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## CYLINDROIDS OR SO-CALLED MUCOUS CASTS IN THE URINE.\*

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ALTHOUGH earlier writers had not infrequently called attention to bodies in the urine whose form resembled that of renal casts, yet it was not till 1870 that Thomas (1), while observing the urine in scarlet fever, carefully studied the forms to which he gave the name cylindroids. This name he applied not alone on account of their resemblance to true casts, but because they so frequently occurred with the latter, and also reacted in a similar manner toward acetic acid. Rovida (2) carefully analyzed them chemically and showed the identity of their composition with that of renal casts. They were mentioned by Bartels (3) and Wagner (4). Bizzozero (5), Eichhorst (6), Neubauer and Vogel (7), von Jaksch (8), Fürbringer (9), Leube (10), and Rosenstein (11) also described them. The most exhaustive study on this subject was made by von Török and Pol-

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lak (12) in a prize essay entitled *Ueber die Entstehung der homogenen Harncylinder und Cyindroide*.

Most of these writers agree, in some measure at least, in recognizing cylindroids as renal products bearing a more or less close resemblance to hyaline casts. Other authors regard them only as forms of mucin. Thus Baginsky (13) spoke of them as hyaline mucous shreds, which may be found in the urine of scarlet-fever patients. Tyson (14) states that occasionally casts may be found which are apparently "pure mucus-molds of the uriniferous tubules." These forms, in his opinion, undoubtedly come from the kidney and must be distinguished from the bands of mucin which are found in hyperacid urines.

Millard (15), in his treatise on Bright's disease, in which he has so carefully and thoroughly distinguished the relations of mucin to albuminuria, speaks of mucous casts, but denies that they have any significance except that they are often mistaken for hyaline casts. The mucous cast, as distinguished from true casts, he maintains, is not an inflammatory product. Vierordt (16), while describing mucin, says: "Several forms are characteristic; among these are cylindroids, or microscopic shreds of mucus which careless observers may mistake for casts. Their origin and diagnostic significance are uncertain; they may be found (accompanying casts) in nephritis, in cystitis, and even in healthy individuals."

Peyer (17) also considers them products of mucus. He gives excellent plates (see Plates 6, 32, and 64) showing various varieties, including prostatic and spermatic cylinders. Saundby (18) coincides with the above views and simply speaks of them as mucous cylinders.

Von Hösslin (19), in 1889, described an unusual form of casts which he found in the urine of an epileptic after a very severe renal colic which lasted eighteen hours. The

urine passed after the attack had a specific gravity of 1.035 and was laden with urates. With the naked eye numerous flakes could be seen floating in the urine. Under the microscope these were found to consist of sharply contoured hyaline casts, branching dichotomously, and between which were finely granular uratic deposits. As the urine was free from albumin, von Hösslin believed that these casts could not consist of any albuminoid substance. Inasmuch as mucin is increased in quantity in renal colic, he therefore asserted that in this case the secretion of mucin was so great that mucin casts were formed in the kidney. The fact that he could never find casts after any of the epileptic attacks which the patient subsequently had, excludes the possibility of including them under this latter group.

In a paper on Tube Casts and their Diagnostic Value, read before this year's meeting of the Association of American Physicians, Danforth (20) divides these bodies (*i. e.*, casts) into two groups, of which one includes the ordinary forms, the other being the mucin casts. These, he states, are "the characteristic morphologic products of catarrhal nephritis and establish its differential diagnosis."

Cylindroids have also been variously mentioned as prostatic cylinders or tubules, spermatic casts, etc. On the other hand, very many recognized standard text-books do not even mention them.\*

*Description.*—Cylindroids are ribbon-like forms, usually of great length and of about the same diameter as renal casts.

\* Da Costa's paper in the *American Journal of the Medical Sciences* for January, 1893, is an excellent proof of this assertion. Although very careful chemical and microscopical examinations of the urine were made in all his cases, yet cylindroids are never referred to. This is all the more striking since nowhere else do these bodies occur more frequently.

They may assume various shapes, due to bends and twists which are usually in their longitudinal axis, giving them a corkscrew appearance. These axial twists are most frequently observed near the extremities. Folds and lateral indentations are very common. The diameter may be uniform or varying; the latter is by far more common. Hence, as a rule, the extremities are narrow and elongated, and often bifurcated. Subdivision into three or even four branches is by no means rare. They are frequently thicker at one end than at the other. Their outlines are delicate, although more highly refracting than hyaline casts. A

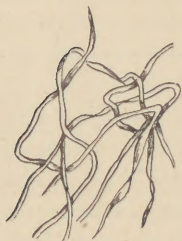


FIG. 1.—Snarl of interlacing cylindroids. (Low power.) From Bizzozero.

very characteristic feature is the longitudinal situation of various grades of delicacy; these markings not alone assist us in finding them, but are also a very important diagnostic feature which distinguishes them from true cylinders.

They may occur isolated or in groups of two or three, or even in large snarls; the latter may often be detected by following up one extremity of the cylindroid (Fig. 1). Not infrequently a specimen is at once cast and cylindroid, as where one end of a cast terminates in a spiral, striated form (Fig. 2). I have observed both extremities assume this form. One example which I saw of this variety had a body like a granular cast (probably due to some extraneous precipitation); in still another example this granular appearance was present in two portions of the specimen, the intervening space being quite hyaline, while the extremities were typically cylindroidal (Fig. 3). Finally, cylindroids may occur inclosed in hyaline casts, as is well shown in Fig. 4.

Like true casts, cylindroids may bear various forms of

epithelium, red and white blood-cells, crystals, detritus, fat-droplets, and bacteria. These may be inclosed within or may simply be adherent. When covered with amorphous deposits they may strongly resemble granular casts.

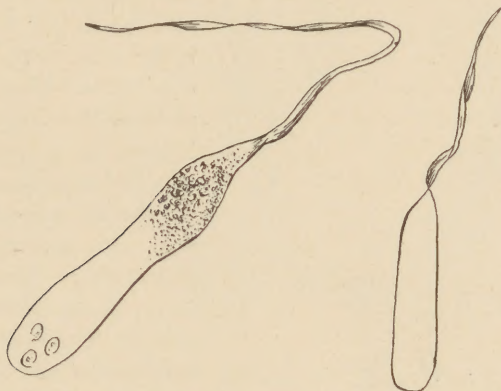


FIG. 2.—Combined casts and cylindroids. ( $\times 400$ .) The specimen to the left was found in an acid urine (drawn by catheter) containing much free uric acid. The specific gravity was 1.030. Albumin and mucin were present in traces, with sugar 0.4 per cent. It contained three renal epithelial cells and numerous small fat globules. Hyaline and fatty casts also were present. The other specimen also is from a gouty urine, very acid, of the specific gravity of 1.032, containing many crystals of uric acid and oxalate of calcium, together with hyaline and granular casts.

Their length is characteristic. According to Bizzozero (5) (*loc. cit.*, p. 281), they may even be one millimetre long. It is common to see them extend over two, three, or even five fields of the microscope. The diameter of the thin forms (Bizzozero) is 1 to 2  $\mu$ ; the broader varieties measure between 5 and 10  $\mu$ . False cylindroids may be much broader than this.

*Classification.*—The classification of these bodies into two great groups—the true and false cylindroids—is of importance, not alone in estimating their diagnostic signifi-

cance, but also in explaining the differences of opinions held by various writers on this subject. That some cylindroids are renal in origin



FIG. 3.—False cylindroid with deposit of amorphous urates. From a case of oxaluria; urine was very acid, specific gravity 1.028; contained urethral shreds, hyaline casts, and a small number of red and white blood-cells. A large trace of albumin and mucin also present. ( $\times 400$ .)

is positively shown by the fact that von Török and Pollak (12) have actually seen them in the uriniferous tubules in sections of a large white kidney, of a waxy kidney, and numerous cases of chronic parenchymatous nephritis. Furthermore, they were also found in the kidneys of rabbits poisoned with cantharides and bichromate of potassium; in experimental stenosis of the renal veins; in ligation of the renal arteries; and also where the ureters were tied off (Fig. 5).

Another very strong proof that cylindroids are formed in the kidneys is shown in the curious casts inclosing cylindroids (Fig. 4). As von Török and Pollak observe, unless we accept the view that the cylindroid already existed in the tubule where it was subsequently inclosed in a mantle of albuminoid material, we must assume that the cylindroid forced its way into the already formed cast. For this, however, it is not rigid enough, as any pressure from behind would simply press the spirals of the cylindroid closer together. The alternation of casts and cylindroids, their occurrence in the same specimen in which

they both contain exactly the same varieties of epithelial cells, blood-cells, detritus, etc., the similarity of their reactions to various chemical reagents—all these attest the

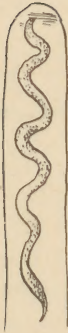


FIG. 4.—A hyaline cast containing a cylindroid. From a case of Bright's disease. (Von Török and Pollak.)



FIG. 5.—Sections of uriniferous tubules containing cylindroids. The specimen at the left was from the kidney of a rabbit in which the renal veins had been narrowed. The one at the right is from the kidney of a rabbit poisoned with cantharides. (Von Török and Pollak.)

correctness of this view. Finally, I have also seen them in urine drawn with the catheter in cases where there was absolutely no indication of pyelitis and cystitis (Fig. 6).

On the other hand, it is just as certain that others are formed outside of the kidneys. They may be readily observed in the secretions of the prostate, Cowper's and Lit-tre's glands, the bladder, vagina, uterus, and urethra. They may also be seen in the urine voided *post coitum*, or after a hard passage, or after what Keyes has termed "milking

the prostate." If any of the above secretions be mingled with perfectly normal urine, cylindroids may then be observed in the specimen (Figs. 7, 8, and 9).

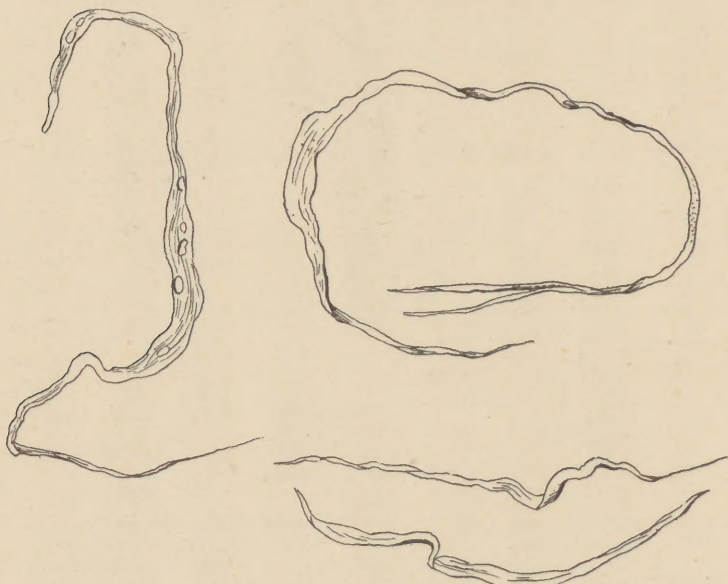


FIG. 6.—Renal cylindroids from a case of typhus fever. Urine contained small trace of albumin, red blood-cells, hyaline and epithelial casts. Cylindroids were soluble in acetic acid. A few adherent red blood-cells in one of the specimens. Urine was high colored, acid; specific gravity, 1.028. ( $\times 400$ .)

Renal cylindroids have been subdivided into three groups: (a) small, narrow threads; (b) ribbon-like bodies; (c) collapsed tubules. Von Török and Pollak also mention another variety where the contours are very vague. This classification referring only to the shape has no practical significance.

*Composition.*—The exact composition of casts being unknown, a corresponding degree of uncertainty must neces-

sarily exist concerning the nature of the basement substance of cylindroids. Of casts, Knoll (21) says that their substance is identical with none of the known forms of albumin—as acid albumin, albumin, albumose, globulin, fibrin,



FIG. 7.—False cylindroids from a case of gout and cystitis. Urine acid; specific gravity, 1.019; faint trace of albumin, large trace of mucin; free uric acid crystals very abundant. Epithelial cells of bladder and pus cells quite abundant. ( $\times 400$ .)

mucin, or peptone. Rovidá (2), who has paid more attention to this subject than any one else, claimed that casts and cylindroids were identical in composition. This is true if pseudo-cylindroids are not included; for, as already shown

above, true and false cylindroids react differently to acetic acid, the former being rapidly dissolved, while of the latter some are unaffected, but others are swollen up and apparently disappear; however, they again become visible after staining.



FIG. 8.—Very long false cylindroid containing blood-cells. Both extremities bifurcated. From concentrated acid urine with traces of albumin and mucin. ( $\times 400$ .)

This effectually disposes of the belief of many who have regarded *all* cylindroids as being simply shreds of mucus. Even admitting that renal cylindroids could consist of mucin, from what part of the kidney could the necessary mucin be obtained? The only rational source would be the pelvis; but in that case they would have a

much less marked resemblance to true casts than they actually possess. Whatever cylindroids are formed there undoubtedly belong to the false variety. Mucus can not be secreted within the kidney, for it contains no muciparous glands. Millard and Danforth still adhere to the possibility of a catarrhal nephritis. The latter writer assumes that the necessary mucin is furnished by the tubal



FIG. 9.—False (spermatic) cylindroids found in urine after passage of hard feces. ( $\times 300$ .)

epithelium, most likely by that of the convoluted tubules. He maintains that, “under certain circumstances, the epithelial cells seem to undergo a change which is equivalent to the ‘mucoid degeneration’ of Ziegler, the protoplasm of the cell being transformed into a mucoid substance, which is afterward cast into the lumen of the tubule, there to aggregate itself with the similar product of neighboring cells.” Such views of pathology may be dismissed as antiquated, for very few writers any longer speak of a catarrhal nephritis. The only other possible explanation would be that mucin, being now recognized as a nucleo-albumin, might arise from changes in the renal cells. However, if so marked a lesion were pres-

ent, we would have other manifestations of a well-marked nephritis.

Thus we may assume that renal cylindroids consist of some as yet unknown albuminoid substance. On the other hand, pseudo-cylindroids are probably formed from some variety of mucin.

*Mode of Formation.*—Of the three theories put forth to explain how casts are formed—viz., (a) by the liquefaction and metamorphosis of desquamated renal epithelium; (b) from secretory products of renal epithelial cells, the so-called vacuoles; (c) the coagulation of an albuminous transudate into the tubules—only the latter comes into play when considering the origin of renal cylindroids. Their very form speaks for the correctness of this assumption, for according to the amount of the transudate will the cylindroid assume the shape either of a thin flat ribbon, or a hollow tube, or a solid cylinder. Originally the albuminous material is coagulated in straight lines; but the urine coming down from the glomerulus while they are still semi-solid, causes the various corkscrew twists, bends, and transverse folds. Their great length and the frequent occurrence of dichotomous division would seem to indicate that they are usually formed in the straight tubules, although it is true that the branching of their extremities might also be explained by a subsequent splitting.

This view will also readily explain the bodies which are cast and cylindroid combined, by assuming either that through some obstruction the transudate was forced to fill out the entire tubule at some point, or that, although its amount was enough to form a cast in some portions, it did not suffice at other parts. The occurrence of snarls of interlacing cylindroids does not weaken this assumption, for Thomas (23) asserts that they may be formed by the meeting in the calyces of the streams from the various collecting tubules.

The occurrence of cylindroids in tubules with unaltered epithelium indicates either the coagulation of transuded albuminous fluids, or that the specimen was carried down from some point higher up. But to discuss this subject at greater lengths would only bring us back to the consideration of all the various theories on the formation of hyaline casts.

Pseudo-cylindroids are simply bands of mucin precipitated in the excretory ducts of the various glands of the urinary tract by the acid reaction of the urine.

*Occurrence.*—It is surprising how frequently these forms may be observed in the urine after we have once learned to recognize them. Where the urine has been mixed with various discharges—as in cystitis, leucorrhœa, or gonorrhœa, after coitus, after a hard passage, etc.—they may be readily discovered, as they are then quite abundant. They are also present in pyelitis, the various forms of nephritis, and congestion of the kidneys; consequently they are present in diphtheria, scarlet fever, and other exanthemata. I have even recently observed them in a case of typhus fever (see Fig. 6). They may occur alone or with casts, frequently alternating with the latter as the renal lesion abates in severity. These are least abundant in the chronic forms of nephritis. In normal urines they are by no means rare. Jaksch (8) (*loc. cit.*, p. 236) found cylindroids very frequently in the urine of children, with and without albumin, where renal disease could otherwise not be demonstrated. Among the non-albuminous urines they are especially liable to occur in jaundice, in concentrated and hyperacid specimens, and, finally, in subjects suffering from gouty manifestations and imperfect metabolism. It is just these cases which give us so much trouble in determining whether or no a trace of albumin might be present. These specimens are usually of a very high specific

gravity (over 1.030), hyperacid, and contain a large quantity of urates; free crystals of uric acid and oxalate of lime are present when the urine is voided, or appear soon on standing. In these cases mucin is always present, often in considerable amounts. Hyaline casts, a moderate number of pus-cells, and at times even red blood-cells (where the pelvis of the kidney or other parts of the urinary tract have been irritated by sharp pointed crystals), are by no means rare in such specimens. Many of these cases are put back and often rejected by life-insurance companies.

False cylindroids have absolutely no relation to albuminaria, but appear to accompany mucinuria. The renal varieties may be present with or without albumin. *The trace of albumin which is so frequently present in these cases is often probably due to the excess of mucin which is so common in these patients.* However, Le Nobel (22) has always found globulin in urines containing cylindroids.

The youngest age at which I have observed them was five years—in a little girl with psoriasis; her family history was decidedly gouty.

*Diagnosis.*—For the purpose of studying the general characteristics of cylindroids, the urine of any patients suffering from gonorrhœa offers a good field, since the forms here present are very easily recognized on account of the distinctness of the longitudinal striation, their greater refracting power, and their length. Moderate powers (300 to 400 diameters) are ample. The delicacy of the contours of these bodies requires that the illumination be not too strong; they may be very easily overlooked when gaslight is used. Staining with Lugol's iodine solution, picric acid, etc., is always of assistance.

Cylindroids are most readily found in freshly voided urine, especially if the minute flakes which are often enclosed in the mucus be examined. These flakes are very

hard to find if the urine has been shaken up. Another means of detecting them is to look for the snarls already referred to.

The differential diagnosis is important. The greatest difficulty will be encountered in distinguishing the true from the false forms. The only absolute test is the solubility of the former in acetic acid and the insolubility of the latter in the same reagent. However, the accuracy of this test is vitiated by the fact that some pseudo-cylindroids will swell up on the addition of this reagent and apparently disappear. Staining with Lugol's solution will, however, show that the specimen can still be rendered visible. However, to carry out this test successfully requires not a little skill in microscopic technique to constantly keep the particular specimen in the field of the microscope.

The presence of albumin, casts, and renal epithelial cells would lead us to expect the renal forms, while an excess of mucin, the admixture with products from the bladder, prostate, urethra, vagina, and uterus, would indicate pseudo-cylindroids. In the latter, also, the striations are coarser, the refractive power is greater, the diameter varies more, the extremities are more frequently divided into more than two branches—in a word, the less the resemblance to true casts, the greater the probability that we are dealing with pseudo-cylindroids. Naturally, the differentiation is materially aided by the presence of adventitious products—viz., spermatozoa, epithelium of the lower urinary tract, etc.

In spite of all these distinctions, the differentiation between these two groups will not infrequently be attended with the greatest difficulties; and in some cases it is even impossible, especially where both forms are present.

From casts cylindroids may readily be distinguished by their length, irregular contours, twists, and, above all, the

longitudinal striations already referred to. Casts resemble a cylinder, while cylindroids are more band-like. Granular casts may be closely simulated where many of these characteristics have been obliterated by the presence of amorphous deposits. I have even seen true blood casts simulated by cylindroids bearing a large number of closely packed red blood-cells. In this connection it might be well for superficial observers to bear in mind how much renal casts differ from the usual typical drawings in most text-books, showing a cylinder with parallel sides and rounded extremities. Hyaline casts are quite frequently irregular in their contours, their sides often taper toward one extremity, bends are common, and Neubauer and Vogel even state (*loc. cit.*, ii. Theil, S. 155) that some may have bifurcated extremities.\*

I have already spoken of the forms which are at once cast and cylindroid—*i. e.*, either the casts with spiral and tapering extremities, which are quite common, or the very rare forms in which cylindroids are inclosed in casts.

*Significance.*—Having thus shown the necessity of regarding these bodies as something more than mucous casts, and having also proved the existence of both true and false cylindroids, the question naturally arises, What is their significance and what prognostic conclusions may be drawn from them?

The pseudo-cylindroids, as such, may be dismissed without another word, as their significance is limited to simply recognizing them as such. Whatever bearings these forms have in diagnosis is merely due to the difficulty which may be encountered in absolutely distinguishing them from the true renal varieties.

\* Examples of the very irregular outlines of casts may be seen in Basham, *On Dropsy connected with Diseases of the Kidney*, London, 1858, Plate IX; Salkowski and Leube, *loc. cit.*, p. 444, Fig. 36; von Jaksch, *loc. cit.*, Figs. 78 and 81.

Leube (10) (*loc. cit.*, p. 447) asserts that in his opinion there is no reason for specially distinguishing cylindroids from ordinary casts, especially as the latter so frequently have lateral indentations and axial twists. Rosenstein (11) (*loc. cit.*, p. 45) denies the right of attributing to cylindroids a special importance which renders their distinction from casts necessary. Fürbringer (9) (*loc. cit.*, p. 36) coincides with the latter.

Thomas (23) believes that where cylindroids are replaced by casts an exacerbation of the nephritis may be inferred; and, *vice versa*, cylindroids take the place of casts when the renal process abates. He also assumes that cylindroids are present where the quantity of albumin is very minute, and that they may even be the only signs of a mild nephritis. The latter may frequently be due to the excretion of infectious elements; in some cases the process resolves; in others it goes on to a nephritis. He suggests that bacterial influences may be discovered in many other cases where cylindroids occur.

The views of von Török and Pollak, Tyson, and others have already been stated.

Danforth, in addition to what has already been quoted of his contention that "mucin casts" establish the diagnosis of catarrhal nephritis, also maintains that these bodies are of great importance in the early recognition of interstitial nephritis.

My own belief is that if we can be absolutely sure that we are dealing with true renal cylindroids, their significance would be about the same as that of hyaline casts. But the value of such inferences is materially lessened by the great difficulties which often attend this differentiation. Not infrequently I have found it impossible. So experienced an observer as Peyer admits the same. Therefore, to attribute any absolutely diagnostic significance to cylindroids is not

justified, as these doubtful cases usually occur where our other means of diagnosing nephritis also leave us in the lurch. Such a conclusion once more reminds us that a diagnosis of nephritis ought not to be made from an examination of the urine alone; but that all the other organs should be interrogated before making absolute statements as to the existence of renal disease.

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